GEOTECHNICAL MANAGEMENT
ROCK ENGINEERING
MINE VENTILATION

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cc: RCV
AWS
DAW
BCC

June 7, 1976

Mr. Robert B. Crookston
The Oil Shale Corporation
10100 Santa Monica Boulevard
Los Angeles, California 90067

RE: PROTECTIVE PILLAR FOR GAS WELLS,
SAND WASH PROPERTY

Dear Bob:

With reference to your letter of May 24 and our telephone conversation of June 2, 1976, I recommend the following dimensions and extraction ratio for the pillar needed to protect the gas wells in the Sand Wash Property:

(1) A 70 degree angle of draw (from the horizontal) between the gas wells at the surface, and a mined out area underground should be used. This gives a pillar 1,600 ft. in diameter with a 46 acre area for a depth of 2,200 ft.

(2) A 35 percent extraction ratio should be used within the pillar defined by the angle of draw. This gives a mining layout with 140 ft. x 140 ft. pillars with 33 ft. spans for a mining height of 40 ft.

(3) Leave a 200 ft. diameter unmined pillar in the mining horizon around the gas well.

CONSIDERATIONS ON PROTECTIVE PILLARS

The above recommendations were based on a literature review of measurements in mining fields where subsidence has taken place, and on practical experience. I feel that an approach to the problem based on available practical experience is more reliable than a

MINING UNDER THE PROTECTIVE PILLAR

I feel that mining can be carried out in this pillar at a low extraction of 35 percent. The recommendations for the extraction ratio in this area were based on a review of the report entitled, "Preliminary Structural Mine Design, TOSCO Sand Wash Project" by Golder Associates. The pillar design was based on a conservative safety factor to minimize pillar failure and to prevent subsidence during the life of the mining operations. As previously discussed with you, the limitations of stability are at the roof pillar lines (pillar punching), rather than on the pillars. This type of failure does not lead to surface subsidence.

CONSIDERATIONS OF MINING METHODS INVOLVING INTENTIONAL SUBSIDENCE

The angles of draw should be reviewed if a modified room-and-pillar method is adopted at Sand Wash involving subsidence. However I believe that drastic changes in the protective pillar should not occur.

I will be pleased to discuss the above recommendations with you at any time in the near future.

Sincerely,

J. F. T. Agapito

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Attachment

mathematical approach based on theoretical assumptions. This is because little is known about the rock mass properties and behavior above the mining zone in the Sand Wash property, and because of the complex mechanisms involved in subsidence.

The table below summarizes the angles of draw measured in different mining fields in the U.S.A. and Europe. A list of references of papers describing these measurements is attached at the end of this letter.

LOCATION	ANGLE OF DRAW	REFERENCE
1. Germany	45^{o} - 60^{o}	1, 2
2. France	55^{o}	3
3. Britain	55^{o} - 65^{o}	4
4. U.S.S.R.	60^{o}	5
5. Netherlands	45^{o} - 60^{o}	6
6. U.S.A. (Pennsylvania)	70^{o}	7
7. U.S.A. (Upper Michigan)	75^{o}	Unpublished

The angles of draw shown in the table are, for the most part, smaller than that recommended for Sand Wash because they apply, in most cases, to longwall mining where almost full recovery is obtained. The only reference pertaining to a hard rock room-and-pillar mine is Number 7 which pertains to the White Pine Mine in Michigan. At this mine over 550 acres of ground have been caved to surface by pillar robbing operations. It is my judgment that the subsidence behavior at Sand Wash would be more similar to White Pine than to the longwall mines. The percentage of subsidence in terms of the mining height should be less in room-and-pillar mining than in longwall mining because more material is left behind. This should cause higher angles of draw.

REFERENCES

1. Flaschentrager, H.,Considerations in Ground Movement Phenomena Based on Observations Made in the Left Bank Lower Rhine Region. Proc. Europ. Cong. Ground Movement, Leeds, 1957,pp. 58-73.

2. Niemczyk, O., Bergschadenkunde (Study of Mining Damages). Verlag Gluckauf, Essen, W. Germany, 1949, 291 pp. (in German).

3. Grard, C. (Mining Subsidence and the Means Permitting the Limiting of their Effects on the Surface) Revue de l'Industrie Minerale, v. 51, January 1969, pp. 35-70 (in French).

4. National Coal Board (England). Principles of Subsidence Engineering Bull. 63/240, 1963, 27pp.

5. General Institute of Mining Surveying. (The Movements of the Rock Masses and of the Surface in the Main Coalfields of the Soviet Union.) Ugletekhizdat, Moscow, 1958, 250 pp. (in Russian).

6. Drent, S., Some Considerations on the Connection Between Time-Curves and the Thickness of the Non-Carboniferous Overburden in the South Limburg Coalfield. Proc. Europ. Cong. Ground Movement, Leeds, 1957, pp. 49-57.

7. Maize, E. R., E. Thomas, and H. P. Greenwald, Studies of Roof Movement in Coal Mines. Study of Subsidence of a Highway Caused By Mining Coal Beneath. U. S. B. M. Rept. Inv. 3562, 1941, 11 pp.